VU VRIJE UNIVERSITEIT AMSTERDAM

VU Research Portal

Commercializing science by means of university spin-offs: an ethical review

van Burg, J.C.

published in
Handbook on the Entrepreneurial University
2014

Link to publication in VU Research Portal

citation for published version (APA)
van Burg, J. C. (2014). Commercializing science by means of university spin-offs: an ethical review. In A. Fayolle, & D. T. Redford (Eds.), *Handbook on the Entrepreneurial University* (pp. 346-369). Edward Elgar.

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:
vuresearchportal.ub@vu.nl

Download date: 05. May. 2023

15. Commercializing science by means of university spin-offs: an ethical review

*Elco van Burg**

INTRODUCTION

Entrepreneurship within universities is important to exploit the full economic and social potential of university inventions. Without entrepreneurial individuals, and a university organization that supports those individuals, new research findings will probably be published and taught, but it is likely that broader value is not fully developed (e.g., Siegel et al., 2004, 2007). Entrepreneurship within universities, for instance in the form of university spin-offs – ventures founded to exploit university inventions – serves to transform technological breakthroughs from university research, which would probably remain unexploited otherwise (Shane, 2002; Meyer, 2006). Therefore, policy-makers have become very interested in university spin-offs and in the concept of an entrepreneurial university as a means for technology transfer and economic growth (Gilsing et al., 2010). Universities have established policies and support infrastructures to support entrepreneurship (van Burg et al., 2008), thereby moving in the direction of becoming entrepreneurial universities (Bramwell and Wolfe, 2008).

However, supporting entrepreneurial activities within universities creates several difficulties, such as the potential conflict of interest between commercial and academic work and the risk to university reputation if founders of spin-offs act inappropriately (Bird et al., 1993; Shane, 2004; Slaughter and Rhoades, 2004). Due to this debate in the popular press as well as within the university, academic entrepreneurs feel sometimes that their behaviour is not welcomed by the university. Therefore, there is a need to review the concept of an entrepreneurial university, and more specifically that creation of university spin-offs, from an ethical perspective. If one of the main goals of universities is to produce sound knowledge, would the usage of this knowledge for economic benefits not corrupt research 'objectivity'? On the one hand, faculty were proud of the success of the Stanford spin-off Google and were happy with the research funding of $US336 million that equity sales delivered to Stanford University. On the other hand, people asked what

these unprecedented cases would imply for renowned universities. The benefits of commercializing science create what Roger Geiger calls the 'paradox of the marketplace':

> [T]he marketplace has, on balance, brought universities greater resources . . . and a more productive role in the US economy. At the same time, it has diminished the sovereignty of universities over their own activities, weakened their mission of serving the public, and created through growing commercial entanglements at least the potential for undermining their privileged role as disinterested arbiters of knowledge. (Geiger, 2004, p. 265)

Thus, the engagement of universities in commercializing research raises the question whether this engagement is good or bad.

This debate on the moral issues raised by the engagement of universities in commercializing of research has been lively, in particular since the 1980s (Feller, 1990). In addition, systematic inquiry of the phenomenon has started (e.g., Jensen and Thursby, 2001; Zucker et al., 2002; Perkmann and Walsh, 2008; Goldstein, 2010; Haeussler and Colyvas, 2011; Tartari and Breschi, 2012). Yet, in the debate on the moral side of commercializing research, empirical findings are often not taken into account. As a result, the empirical validity of some arguments is questionable. Moreover, many contributions to this debate have been remarkably one-sided. Therefore, this study aims to bring the debate an important step forward by collecting the arguments, evaluating them by reviewing the empirical findings and taking into account diverse stakeholders and different ethical perspectives. In this respect, this study goes beyond unproductive dichotomies between 'old-school Mertonian-style' and 'new-school profit-oriented' research (cf. Owen-Smith and Powell, 2001).

This study focuses on the ethical evaluation of university spin-off creation, as this way of commercializing university knowledge combines a number of important commercial activities, namely licensing, contract research and the transfer of personnel and students. First, a review of the literature collects the different pros and cons of the creation of university spin-offs. This inventory of arguments is, where possible, evaluated by a review of empirical studies that demonstrate the substance and significance of the arguments. Here, this study contributes to the debate on the commercialization of science by reviewing the advantages and disadvantages and showing that some of them are not empirically supported, while others are substantial. In this way, I extend earlier reviews that focused only on the (negative) effects of patenting activities (i.e., Thursby and Thursby, 2005; Baldini, 2008; Larsen, 2011). Second, deontological and teleological ethical perspectives are used to evaluate these arguments and create a synthesizing reflective equilibrium (cf. Rawls, 1999), thus

extending previous reviews of the empirical evidence by performing an ethical evaluation. The reflective equilibrium balances current knowledge of advantages and disadvantages of university spin-off creation, evaluated by different ethical theories. As such, this reflective equilibrium provides a new foundation for the debate on the commercialization of science. This balance of different arguments and perspectives, while taking into account the empirical results, provides a moral criterion serving as an instrument to evaluate university spin-off creation. In addition, the review in this study contributes by specifying a number of directions for further inquiry.

ARGUMENTS IN SUPPORT OF UNIVERSITY SPIN-OFF CREATION

Knowledge Utilization

One of the main reasons to foster the creation of university spin-offs is the knowledge utilization objective (Bozeman, 2000; Siegel et al., 2004, 2007). Universities create new knowledge and produce inventions. Much of the research underlying these inventions has been paid for by taxpayers, at least in the case of public universities. Therefore, it is desirable that the benefits of this research feed back to taxpayers, to society. This is partly done by teaching students the results of the research and by publishing research findings in books and academic journals (Perkmann and Walsh, 2007). The value of inventions can be further unleashed by transferring this technology to the market, which may create more and better products and services, thus possibly increasing living standards for taxpayers. Thus, commercialization of science is justified by the benefit and use of the public (Powell and Colyvas, 2008).

Many inventions get to the market through established firms that acquire property rights of university inventions (Thursby et al., 2001). However, some inventions are not feasible for exploitation by established firms. This especially applies to inventions in early development stages and inventions that require the tacit knowledge of the inventors for their development (Thursby et al., 2001; Mitchell et al., 2002; Zucker et al., 2002). In these cases, exploitation by the inventor him- or herself in a university spin-off ensures the involvement of the inventor (Hsu and Bernstein, 1997; Shane, 2004). As such, spin-off firms are important catalysts in spurring technology flows (Rappert et al., 1999) and can serve to realize the commercial and social benefits of a discovery (Meyer, 2006).

Economic Growth

University spin-offs can contribute to economic growth, both locally and on a broader, national scale (Shane, 2004; Mueller, 2006; Gilsing et al., 2010). Although the relationship between university spin-off creation and economic growth is not linear (Mowery and Sampat, 2005), research results do imply that new high-tech companies such as university spin-offs contribute significantly to economic growth (Shane, 2004, 2009; Mueller, 2006). Support from universities helps these firms to grow (O'Shea et al., 2005; Powers and McDougall, 2005). For spin-off firms, maintaining the relationship with the university is important to obtain access to expertise, keep abreast of university research, get assistance and help with specific problems, and have access to public funding (Zucker and Darby, 1998; Zucker et al., 2002; Geiger, 2004). Thus, by enabling and supporting university spin-off creation, universities can contribute to economic growth.

Learning From Another 'Culture'

A popular idea is that faculty are too isolated in their ivory tower. Their tasks of independent observation and theorizing may have made them introspective with little attention for the outside world. One of the benefits of university spin-offs, as has been argued, is that they enable learning from the different culture of business (Welsh et al., 2008). Moreover, as there is no fundamental separation between the science and industry in terms of technology and research subjects, university spin-offs fulfil an instrumental bridging role (Powell and Owen-Smith, 2002). So, engaging in university spin-off creation can result in sharper market foci of faculty and the emergence of new research ideas (Feller, 1990).

A number of researchers have aimed to quantify this effect by examining whether academic researchers who engage in industry relationships in general and spin-off activities in particular have more research output in terms of published papers. Assuming that engagement in commercial activities spurs creativity and leads to potential new and fruitful research directions, higher publication rates are hypothesized. This hypothesis is confirmed by the finding that such inventor-authors publish at or above average publishing rates of faculty (e.g., Zucker et al., 1998; Lowe and Gonzalez, 2007; Larsen, 2011).

Revenue Generation

The generation of university spin-offs provides income for universities (Slaughter and Leslie, 1997; Jensen and Thursby, 2001; Colyvas et al.,

2002; Leute, 2005; Welsh et al., 2008). This income can result from patents or licences sold to these companies. Furthermore, many universities have policies to take equity in spin-off companies, which gives them the benefit of goal alignment and control, but also the ability to benefit from all the business activities related to the university inventions (Bray and Lee, 2000; Shane, 2004). Researchers report that some universities have positive revenues of technology transfer and in particular from equity holdings in university spin-offs (Bray and Lee, 2000; Chapple et al., 2005). Spin-offs may also bring complementary financial benefits because they often attract public funding, which is partly spent at the university. For instance, Hsu and Bernstein (1997) found that MIT spin-offs used grants to fund research at the university.

However, it is not evident whether there is always a net benefit for universities. For example, Stevens and Bagby state that it is 'unclear what benefits are distributed or what the incentives are for the instruction and service functions of universities; . . . there is no consensus regarding who benefits or should pay for knowledge creation and transfer' (Stevens and Bagby, 2001, pp. 264, 266). One of the main questions is whether more public money flows to private companies than the other way around. It seems that only a small number of top universities have net revenues from licensing and spin-off activities, but that the majority of the universities lose money on technology transfer (Geuna and Nesta, 2006; Klein et al., 2010).

ARGUMENTS AGAINST UNIVERSITY SPIN-OFF CREATION

Reduced Academic Commitment

The main reasoning opposing the commercialization of science and the creation of university spin-offs argues that conflicts of interest will arise. On the one hand, advancing academic knowledge is the primary goal of a university researcher. On the other hand, he or she is stimulated to engage in entrepreneurial activities that also need investment in time and effort. This could create a tension between the academic tasks versus the commitment to private entrepreneurship (Bird et al., 1993; Renault, 2006).

Empirical investigation of this topic, however, suggests that this tension is not very pronounced (Steffensen et al., 2000; Martinelli et al., 2008; Goldstein, 2010), as the portion of faculty expressing interest in licensing is remarkably low, indicating that faculty have not become too commercial (Thursby and Thursby, 2005), or because of effective 'conflict of interest'

policies (Argyres and Liebeskind, 1998; Leute, 2005; Powell and Colvyas, 2008; Welsh et al., 2008). In addition, research on the relationship between patenting and entrepreneurship activities on the one hand and the publishing tasks on the other indicate that engagement in commercialization in general does not result in reduced academic research output (Zucker and Darby, 1998; van Looy et al., 2006; Lowe and Gonzalez, 2007; Baldini, 2008; Crespi et al., 2011). Moreover, results show a positive relationship between the quality of articles, measured by the number of citations, and the number of university spin-offs (Di Gregorio and Shane, 2003; Powers and McDougall, 2005). This indicates that entrepreneurial activities do not reduce academic efforts or vice versa; they rather tend to reinforce each other.

Research Direction Change

Related to the potentially reduced academic commitment is the objection that engagement in university spin-off creation will change research directions (Colyvas and Powell, 2007). As Feller states (1990, p. 342), '[T]he institutional incentives to foster faculty research related to reducing technical and economic uncertainty increase as well, even when these lines of research diverge from "academic advances in knowledge"'. Whereas research output in quantitative terms does not change, the content of the research may change. Instead of executing fundamental research, faculty engaging in entrepreneurial activities and industry relationships may focus on research directions that have more commercial opportunities (ibid.). As a result, research that benefits the public interest but has no opportunity to contribute to a market solution could be abandoned (Krimsky, 2003). Instead, commercial success of particular research directions can lead to strengthening those directions, resulting in over-embeddedness that reduces both future academic and commercial success (Owen-Smith and Powell, 2003). Maintaining the focus on fundamental research will therefore be more beneficial over the long term, even in economic and commercial terms, because fundamental research can result in path-breaking innovations (Glenna et al., 2007; Lacetera, 2009). Moreover, as a result of growing commercial and monetary interests, the autonomy of researchers to choose their own direction could be lost (Kleinman and Vallas, 2001).

Empirically, the existence of changes in research directions is still indecisive (Larsen, 2011). Some researchers have observed that researchers involved in commercialization activities do more applied research (Godin and Gingras, 2000; Gulbrandsen and Smeby, 2005) or shift towards more applied research (Azoulay et al., 2009). Others, however, did not find a change in research directions (Ylijoki, 2003; Thursby and Thursby, 2005;

Martinelli et al., 2008). In addition, Thursby et al. (2007) show in a simulation study that a research shift is likely to occur not at the expense of fundamental research, but at the expense of leisure time.

Anti-commons Effect

One of the effects of having private parties such as spin-off companies commercializing university research could be that this research may not be shared freely. Because the rights on the intellectual property are sold and since commercial interests are involved, university researchers are not allowed to communicate openly about the research involved since competitors could be listening. As a result, only the research group that invented a certain technology can build on the research in follow-up research, but are not allowed to present their research results in the outside world, nor are they able to invite other researchers around the world to join their research direction. This effect is called the 'anti-commons effect': commercialization of research can restrict communication and exchange amongst scientists (Vallas and Kleinman, 2007; Welsh et al., 2008). Some argue that this is against one of the key values of universities (Krimsky, 2003; David, 2004), namely 'to create and sustain an "intellectual commons": a knowledge archive openly accessible to all members of society' (Argyres and Liebeskind, 1998, p. 428).

The existence of the anti-commons effect is empirically confirmed (Murray and Stern, 2007), although its impact does not appear to be very large or significant (Chang and Yang, 2008; Tartari and Breschi, 2012). Haeussler (2011) found that scientists are more likely to share information with others if they adhere to the 'open science' norm; Mars et al. (2008) report that communication of research results among students decreased if these students were acting as entrepreneurs commercializing the research results, and similarly Martinelli et al. (2008) reported some anecdotal evidence of decreased cooperation among faculty. Moreover, some studies have found that publications of which the intellectual property is protected by a patent receive slightly fewer citations than their unpatented pairs (Murray and Stern, 2007; Fabrizio and Di Minin, 2008).

Threats to Objectivity

Engagement of faculty in commercial activities such as spin-offs could result in research that becomes biased, because of the commercial interests. An example is the systematic bias that has been found in drug-testing studies that are sponsored by pharmaceutical companies (Krimsky, 2003; Lexchin et al., 2003). Many people argue that university research should

be 'objective' and therefore free from (monetary) interest in the outcome of the research (i.e., Feller, 1990; Argyres and Liebeskind, 1998; Krimsky, 2003; Slaughter and Rhoades, 2004; Vallas and Kleinman, 2007). The empirical research of Colyvas (2007) has demonstrated that institutional change resulted in acceptance of commercial and monetary interests, which might indicate that the norm of monetary disinterestedness is eroding (see Kleinman and Vallas, 2001). In addition, a formal relationship of a university with a spin-off firm creates the risk of damage to the public reputation of the university's objectiveness if inappropriate or 'unscientific' behaviour of the spin-off company is directly associated with the university (Blumenthal, 1992; Shane, 2004).

Inequity Among Faculty

One of the potential side-effects of faculty's engagement in university spin-off creation could be that some faculty acquire a higher total income than other faculty that do not have these revenues. Differences in faculty pay because of entrepreneurship profits may cause envy (Slaughter and Leslie, 1997; Argyres and Liebeskind, 1998). Up till now, empirical research on university spin-offs did not report this inequity problem.

Departure of Faculty

In the case that university spin-offs are founded by university faculty, they will probably devote (part of) their time to this new venture and may eventually leave their academic careers. This could be a disadvantage, in the case that the university wants to keep this faculty longer on board. Slaughter and Leslie's (1997) research indicates that this issue is not perceived as problematic, nor is it reported in any other empirical study.

Unfair Competition by Spin-offs

Because university spin-offs typically exploit public-funded research and since they often receive support by the university, university spin-offs can be considered as 'state-sponsored' enterprises (Mars et al., 2008). This state sponsoring could create unfair competition relative to new ventures that have to arrange support themselves (Bird et al., 1993). The validity of this argument depends on the question of whether 'independent' ventures really do not receive support. In many countries and regions, entrepreneurship is promoted and sponsored with incubators, funds, and so on, such as the SBIC grant in the US (Lundström and Stevenson, 2005). This

implies that many 'independent' new ventures also can be considered to be to some extent state-sponsored.

DEONTOLOGICAL ETHICAL EVALUATION

To evaluate these advantages and disadvantages from a normative perspective, I will use two radically different ethical points of view, namely deontological and teleological ethics. Deontological ethics evaluates actions by assessing whether these actions conform to some specified set of rules. The foundations of this ethical philosophy are laid out by Immanuel Kant (Micewski and Troy, 2007). His basic rule to decide on just actions is: 'Act only on that maxim whereby you can at the same time will that it become a universal law' (Kant, 2005, p. 81 [421]). Based on this rule, specific deontological norms can be developed. For example, John Rawls advocated a contractarian approach, in which the Kantian maxim is translated as 'inherent moral standing of persons' articulated in a social contract (Lefkowitz, 2003). In this way, other ethical norms can also be considered as 'deontological', meaning that people have to adhere to these norms rather than base their evaluations on the consequences of their actions (ibid.).

I will discuss two deontological imperative approaches to evaluate university spin-off creation: the Mertonian ethos of science and the Kirznerian ethics of finders–keepers. The Mertonian ethos of science is relevant because it is the ethos most authors in the debate on commercialization of university knowledge refer to (e.g., Cook-Deegan, 2007). Although originally purely descriptive, the Mertonian ethos of science is often used as a (idealized) deontological norm for the appropriate behaviour of university scientists in the debate on university spin-off creation. On the other hand, the Kirznerian finders–keepers ethic is selected because in entrepreneurship theory the theorizing of Israel M. Kirzner is increasingly seen as one of the basics (Sarasvathy et al., 2003; Douhan et al., 2007; Foss et al., 2007). Moreover, Kirzner has developed a theory of distributive justice for an entrepreneurship context, which is similar to other emerging ethical evaluations of the specific distribution problems in entrepreneurial situations (cf. Dew and Sarasvathy, 2007). Thus, this Kirznerian finders–keepers ethic provides an important concept representing the entrepreneurship side of the debate on university spin-off creation. As such, these two perspectives provide extremes with regard to normative thinking about science and entrepreneurship, and are therefore likely to cover the continuum of perspectives on this issue.

Merton: Ethos of Science

The sociologist Robert K. Merton studied scientific practice to observe the 'normative structure of science' underlying the behaviour of scientists. Merton performed this research in the late 1930s and early 1940s; these studies are collected in *The Sociology of Science* (Merton, 1973). At the time of Merton's studies, the legitimacy of science was questioned because of developments that were not commonly accepted by the public, such as the German and Soviet Union ideological science and the scientific discoveries that were used to improve weapons. Merton sought answers to the question of how scientific knowledge can still be a source of universal truth if so many social structures are involved. To answer this question, he searched to identify the 'ethos of science', the social contract binding the behaviour of scientists. Merton identified four sets of 'institutional imperatives' (ibid., pp. 270–78):

Universalism means that science transcends the particularity of the investigator(s). *Communalism* (or communism) describes the common ownership of the goods produced by scientific investigation. *Disinterestedness* refers to scientific investigation without considerations of personal gain or other individual interests. *Organized scepticism* means a scientist employs 'temporary suspension of judgment and . . . detached scrutiny of beliefs in terms of empirical and logical criteria' (ibid., p. 277). These norms are tacit and also idealized. The latter can be illustrated with the norm of disinterestedness: for instance, each scientist is at least interested in getting publishable results. Merton acknowledged that these idealized norms of science were not always actually followed by scientists (ibid., pp. 383–412), which was also argued by other researchers (Mitroff, 1974; Montgomery and Oliver, 2009).

Regardless of the exact descriptive value, the Mertonian norms are often used as norms characterizing 'basic, fundamental or academic science and are distinguished from applied or industrial science' (Slaughter and Leslie, 1997, p. 178). Table 15.1 displays an evaluation of advantages and disadvantages of university spin-off creation according to the applicable Mertonian norms of universalism, communalism and disinterestedness. This makes clear that university spin-off creation in particular contradicts disinterestedness (Kleinman and Vallas, 2001; Owen-Smith and Powell, 2001; Krimsky, 2003; Vallas and Kleinman, 2007). When an individual researcher is involved in a university spin-off, this implies that he or she has an interest in the performance of this new venture. Because the venture is (partly) based on his or her research, this means that this research is no longer free from interest in the outcomes of the research. Furthermore, the anti-commons effect, implying that knowledge can no longer be shared

Table 15.1 Mertonian evaluation of university spin-off creation

Advantages	Evaluation	Disadvantages	Evaluation
Knowledge utilization	N/A[a]	Reduced academic commitment	N/A
Economic growth	N/A	Research direction change	Contradicts disinterestedness
Learn from other 'culture'	N/A	Anti-commons effect	Contradicts communalism
Revenue generation	Contradicts disinterestedness	Threats objectivity	Contradicts universalism
		Inequity among faculty	N/A
		Departure of staff	N/A
		Unfair competition	N/A

Note: [a] The Mertonian norms are not applicable to evaluate these advantages and disadvantages.

openly and freely, does contradict the norm of communalism (Argyres and Liebeskind, 1998; Krimsky, 2003). In addition, the threat to objectivity contradicts the norm of universalism, as the essence of the universalism norm is that research should be objective and transcending the particularity of the investigator (Slaughter and Rhoades, 2004). In sum, evaluating university spin-off creation by means of Mertonian scientific ethos shows that university spin-off creation to a large extent contradicts these three norms.

Kirzner's Finders–Keepers Ethics

Kirzner's (1989) theory is based on the Austrian School of Economics, which provides a different perspective on the market than mainstream neoclassical economics. For this study one particular consequence of Kirzner's theory is of interest, namely the implication for the division of profit in the market (Kirzner 1989; Burczak, 2002). Kirzner considers knowledge of economic opportunity, technology, potential market demand and resource availability as subjective. This knowledge depends on individual perception and can be wrong or can be right. Entrepreneurs use their subjective knowledge to discover economic opportunities. This discovery, thus, is dependent upon the individual; it is possible that no other person has the knowledge required to discover a particular economic opportunity. Because of this subjective perception involved in the discovery of an opportunity, the opportunity can be treated as if it does not exist

without that person. Stated differently, it can be said that the entrepreneur creates products 'ex nihilo' (Kirzner 1989, p. 13). As a consequence, the output created by the entrepreneur is *discovered* output. According to Kirzner, in this case a so-called 'finders–keepers ethic' 'is consistent with what appear to be widely shared moral intuitions' (ibid., p. 17). Kirzner (ibid.; original emphasis) sees this finders–keepers ethic as different from a first-claimant ethic:

> One who finds a beautiful, previously unowned seashell and takes possession of it is entitled to that seashell, we interpret the finders–keepers ethic to mean, not because he was the first to register a claim to it, but because he found it. Not only was the seashell unowned and unclaimed before he found it, but it was in fact undiscovered as well. In other words the seashell had, insofar as human awareness goes, no *existence* prior to its discovery. By finding it, the seashell's discovery has, in a sense, *created* it.

The consequence is that because the finder of an entrepreneurial opportunity is more entitled to it than anybody else, he or she also has more right on the profits of the discovery. A fundamental condition to assign the property of the entrepreneurial opportunity to the finder is that the opportunity itself was 'not fabricated out of prior inputs, it was not the result of a deliberately undertaken research programme' (ibid., p. 152). But even in the case where prior inputs play a role in the discovery, as in a university spin-off based on the findings of a systematic research programme, still the ultimate discovery of the entrepreneurial opportunity as existing outside the immediate results of the research programme is attributable to the discoverer (Shane, 2000). As a result, simple distributive justice rules appear not to apply because 'naive applications of the contractarian framework to innovations assume novelties instantaneously reveal their full consequences to decision makers, at least probabilistically', as Dew and Sarasvathy (2007, p. 274) have argued.

Employing this finders–keepers ethic enables evaluating the advantages and disadvantages of university spin-off creation from a different perspective. Table 15.2 summarizes this ethical evaluation. Fundamental in the Kirznerian discovery justice is that discovering an opportunity is different from the inputs in the research and discovery process (cf. Dew and Sarasvathy, 2007). Thus, it can be argued that the commercialization of research results involves a different realm than the research realm. Knowledge utilization therefore is not linearly connected with the academic research underlying this commercialization. Depending upon the efforts from the university side into the commercialization (and the search for entrepreneurial opportunities), the discovery of the ultimate opportunity is at least partially owned by the entrepreneur. As a result

Table 15.2 Kirznerian evaluation of university spin-off creation

Advantages	Evaluation	Disadvantages	Evaluation
Knowledge utilization	Yes: Is a different discovery	Reduced academic commitment	N/A
Economic growth	N/A[a]	Research direction change	Research differs fundamentally from entrepreneurship
Learn from other 'culture'	N/A	Anti-commons effect	No: Knowledge is subjectively owned
Revenue generation	Yes: For discoverer	Threats objectivity	N/A
		Inequity among faculty	No: Revenues created by entrepreneur
		Departure of faculty	N/A
		Unfair competition	No: Opportunity created by entrepreneur

Note: [a] The Kirznerian norms are not applicable to evaluate these advantages and disadvantages.

of this distinction, there is a natural boundary between entrepreneur and inventor (in the case these two are different people) and at least between the entrepreneur and the other research group members. In this line of reasoning revenues from the university spin-off are also legitimate, and at least partially entitled to by the entrepreneur. This can create income differences among faculty, but these are legitimate because no one else (could have) discovered this opportunity. In sum, evaluating university spin-off creation from a Kirznerian discovery ethics results in an evaluation that is supportive for 'academic entrepreneurs'.

TELEOLOGICAL EVALUATION

Evaluating actions by a teleological ethical theory means that we focus on the consequences of the actions. Teleological ethics, also known as consequentialism or utilitarianism, assumes that something is done for personal or collective benefit, and not necessarily because it is the right thing to do (Frankema, 1973). Teleological ethical theory argues that an action is good if it produces the greatest amount of good for the greatest number of

Table 15.3 Teleological evaluation of university spin-off creation

Advantages	Evaluation	Disadvantages	Evaluation
Knowledge utilization	AS: Neutral EG: Positive	Reduced academic commitment	N/A: Not supported
Economic growth	AS: Neutral EG: Positive	Research direction change	AS: Moderately negative: sometimes changes EG: Moderately negative: Sometimes changes
Learn from other 'culture'	AS: Neutral EG: Positive	Anti-commons effect	AS: Moderately negative: to some extent existing EG: positive
Revenue generation	AS: Positive if existing EG: neutral: ambiguous	Threats objectivity	AS: Moderately negative: to some extent existing EG: neutral
		Inequity among faculty	N/A: Not supported
		Departure of faculty	N/A: Not supported
		Unfair competition	AS: Neutral EG: Potentially negative if existing

people (DeConinck and Lewis, 1997). This evaluation depends obviously on how we define 'good'. For our purposes, let us consider the consequences for two different goods: the first is the advance of fundamental science, the second is economic growth (cf. Bozeman, 2000). I discuss the consequences of university spin-off creation for these two different goods. Here, the review of empirical results as discussed in the literature review section provides insight into the *consequences*, whereas the deontological evaluation only focused on the *norms* and thus did not take into account the consequences observed in empirical studies. Table 15.3 presents an overview of the evaluation, whereby 'AS' refers to the good of 'advancing fundamental science' and 'EG' refers to the good of enhancing 'economic growth'.

With regard to the advantages of university spin-off creation, advancing fundamental science is not hindered substantially, whereas economic growth is generally fostered. The literature review showed that

knowledge utilization, economic growth and the effect of learning from the business culture are enhanced by university spin-off creation. With regard to revenue generation for the university, research results were ambiguous. Moreover, it is unclear whether revenue generation for the university would foster economic growth. Considering the goal of advancing fundamental science, revenue generation for the university – if any – is likely positive, because it provides funding to perform fundamental research.

The evaluation of the disadvantages of university spin-off creation shows more mixed results. First of all, a number of disadvantages were not supported by the reviewed empirical research and are therefore excluded from the evaluation (indicated by 'N/A' in Table 15.3). With regard to the potential change in research directions, empirical studies have observed this change in some cases. The shift from fundamental to more applied research, if existing, is obviously detrimental to advancing fundamental research. Moreover, a change towards applied research is possibly also detrimental to long-term economic growth, as radical innovations by fundamental research results are more likely to generate sustainable competitive advantage (Owen-Smith and Powell, 2003; Glenna et al., 2007; Lacetera, 2009). Regarding the anti-commons effect, the goods of advancing fundamental science and economic growth result in different evaluations. Research findings indicate a small anti-commons effect, which could reduce the efficiency of fundamental academic research because research results are not openly shared. On the other hand, it is often stated that economic growth is enhanced by well-functioning markets and sustainable businesses. One of the means to create a sustainable business is by protecting the intellectual property, which potentially results in an anti-commons effect. With regard to the threat to objectivity, research results show that this threat exists and that the objectivity of research is sometimes undermined. For advancing academic science, this is obviously negative. On the other hand, it is not clear whether this has an impact on economic growth. Finally, unfair competition created by supporting spin-off creation could have a detrimental effect on economic growth, assuming that economic growth is fostered the most by fair competition in the market. The literature review, however, showed that it is unclear whether university spin-off support really creates unfair competition. Moreover, the unfair competition neither appears to harm nor to foster science.

In sum, the teleological ethical evaluation of university spin-off creation shows a number of elements that enhance both the goods of advancing academic science and economic growth. On the other hand, a number of elements were identified that likely harm these goods. In general, the effect of university spin-off creation is likely advancing the greatest amount of

good for most of the people (assuming that the distribution of profits in the society is reasonably equal). If the remaining disadvantages of university spin-off creation could be reduced, the advantages clearly outperform the disadvantages.

A REFLECTIVE EQUILIBRIUM

The inventory of advantages and disadvantages of university spin-off creation provides the arguments to evaluate the commercialization of university knowledge by means of university spin-offs. The deontological and teleological perspectives show different evaluations. Now these evaluations will be integrated in a reflective equilibrium. Subsequently, I draw the contours of an ethically sound university spin-off policy.

A reflective equilibrium means that we come to a judgement that is aligned with a balance of the different principles we adhere to (i.e., the equilibrium), and that at the same time takes into account the current knowledge of conditions and outcomes (i.e., reflective) (Rawls, 1999). In this study, I have explored two very different sets of normative principles under the heading of a deontological evaluation. The consequences of university spin-off creation are reviewed under the heading of a teleological evaluation. The review of empirical results for each of the advantages and disadvantages shows that some of them are not significant, while others are actually substantial.

The arguments that are not consistent with the empirics can be taken out of the equilibrium. On the advantages side, the aspect of net revenue generation required is not supported. Regarding the disadvantages, the issue of reduced academic commitment is not consistent with data on publication results. As this could be the result of having the right incentives and structures in place, as some authors have argued (Ambos et al., 2008; Chang et al., 2009), universities should be careful not to neglect this disadvantage, but it does not play a role in our equilibrium. Furthermore, the disadvantage of inequity among faculty because of unequal benefits is not supported by the empirical evidence, which is also the case for the departure of faculty. In sum, the equilibrium includes three remaining advantages of university spin-off creation: (1) knowledge utilization, (2) economic growth, and (3) learning from the other 'culture'. Also, three disadvantages remain: (1) the research direction change, (2) the anti-commons effect, and (3) the threat to objectivity.

An equilibrium of these advantages and disadvantages, aligned with the ethical evaluations from different perspectives, tends towards the judgement that university spin-off creation is desirable if detrimental

effects can be mitigated as much as possible. The balance of this equilibrium is constructed as follows. On the one hand, according to Mertonian norms, furthering university spin-off creation is not desirable. On the other extreme, according to Kirznerian logic, nothing is wrong with university spin-offs and private benefits from public-funded research. Furthermore, from a teleological perspective, the three supported advantages are contributing to economic growth and not reducing the advancement of science, whereas the change in research directions and the threat to objectivity are evaluated as negative for both advancing science and economic growth, and the evaluation of the anti-commons effect differs per defined good. Because economic growth is probably creating a good for more people than advancing science as such, the teleological evaluation tends towards the judgement that university spin-off creation is desirable. Moreover, the objections from a Mertonian viewpoint can be mitigated to some extent by designing the right structures governing the creation of university spin-offs, which reduces the disadvantages. Under the condition that these detrimental effects can be mitigated, the benefits of university spin-off creation, especially from a Kirznerian and teleological evaluation, appear to outweigh the disadvantages.

This reflective equilibrium is subject to mitigating the three disadvantages while conserving the already existing instruments that reduce the other disadvantages. The three disadvantages that need attention are: the research direction change, the anti-commons effect and the threat to objectivity. For (university) policy-makers, faculty and academic entrepreneurs the awareness of these three potential disadvantages is important. The change in research directions can probably be reduced by incentivizing not only the quality of the research but also the direction of the research (Thursby et al., 2007). The anti-commons effect is more difficult to deal with, although developments in the direction of open science appear to be driven by the intention to enhance the free sharing of academic knowledge (David, 2004; Rhoten and Powell, 2007). This direction is one that provides potential (David, 2004) and needs more attention, in particular in combination with commercialization of this knowledge (cf. Bozeman, 2007; West, 2008). An effective way to reduce the threat to objectivity is to increase the transparency of funding flows (Smith, 1998; Krimsky, 2003) as well as the enhancement of formal conflict of interest policies (Argyres and Liebeskind,1998; Leute, 2005; Powell and Colyvas, 2008; Welsh et al., 2008). In general, one of the important design principles to enhance both fundamental science as well as to stimulate university spin-off creation is the creation of a 'dual' structure. In this structure, the commercial activities are separated as much as possible

from fundamental research, both in a managerial and a physical sense. Of course, especially in early stages of the development of the spin-off company, the scientific endeavour and the commercial path intermingle and boundaries have to be negotiated (Rappert et al., 1999). But in the long term, as well as in the formal rules, these two activities have to be separated to be able to enhance both fundamental science and spin-off creation (Debackere and Veugelers, 2005; Ambos et al., 2008; van Burg et al., 2008; Chang et al., 2009).

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This ethical review of the university spin-off phenomenon and the construction of a reflective equilibrium make an important contribution to a more constructive debate, based on valid arguments and different perspectives. To advance this debate even more, important research questions have to be answered. First, the created equilibrium is 'reflective' in the sense that it is dependent upon the current state of knowledge regarding university spin-off creation (Rawls, 1999). Future research can discover other disadvantages or can show that disadvantages are increasing over the long term, for example by eroding the still existing Mertonian norms (Slaughter and Rhoades, 2004; Rhoten and Powell, 2007). Therefore, systematic enquiry is required to update the equilibrium and to enable decision-making based on sound knowledge. Second, the reflective equilibrium in this study is based on two deontological perspectives and two teleological evaluations. More perspectives could be added, in order to challenge or strengthen the constructed equilibrium. Third, an issue that becomes more important when commercialization practices are more and more replicated around the world is the study of the diverse legal and social regimes regarding universities and entrepreneurship. Most literature, including this review, implicitly assumes uniformity in practices around the world. Most research has focused on the USA and to a lesser extent on Western Europe. To develop policy and make normative recommendations, an understanding of the national, local and regional context is needed. Fourth, the literature review showed that it is necessary to study the net revenues from university spin-offs as well as other commercialization practices such as licensing. Fifth, the issue of potential unfair competition needs further research. Many new companies are supported by government and support organizations. It is worth considering whether this creates inequality in open market systems such as in the USA or in Europe.

CONCLUSION

The concept of the entrepreneurial university has raised lively debates around the moral question: is the increased role of commercial activities in the university good or bad? This study integrates the different lines of reasoning regarding the moral issues generated by establishing more entrepreneurial universities in general and the commercialization of science by means of university spin-off creation in particular. As such, an important contribution to this debate is the construction of an integral and balancing reflective equilibrium that can be used as a moral criterion. I conclude in this review that commercializing science by means of university spin-offs is ethically desirable on the condition that disadvantages can be mitigated by designing appropriate organizational structures. This has important implications for the organization of entrepreneurial universities. Essential design principles need to focus on creating incentive structures that support the pursuit of fundamental research alongside more applied research, supporting open science where possible, and separating commercial activities as much as possible from fundamental research. Future work and debates need to generate continuous attention for issues such as research objectivity and the contribution of science to society to update the reflective equilibrium and to notice whether unintended long-term effects on changes in the value system of scientists occur. In this respect, this study provides a basis for a continued discussion that draws on sound arguments.

NOTE

* I am grateful to Lambèr Royakkers and Georges Romme for their helpful suggestions and comments. Financial support for this research was provided by the TU/e Innovation Lab at Eindhoven University of Technology. The usual disclaimers apply.

REFERENCES

Ambos, T.C., K. Mäkelä, J. Birkinshaw and P. D'Este (2008), 'When does university research get commercialized? Creating ambidexterity in research institutions', *Journal of Management Studies*, **45**(8), 1424–47.
Argyres, N.S. and J.P. Liebeskind (1998), 'Privatizing the intellectual commons: Universities and the commercialization of biotechnology', *Journal of Economic Behavior and Organization*, **35**(4), 427–54.
Azoulay, P., W. Ding and T. Stuart (2009), 'The impact of academic patenting on the rate, quality and direction of (public) research output', *Journal of Industrial Economics*, **57**(4), 637–76.

Baldini, N. (2008), 'Negative effects of university patenting: Myths and grounded evidence', *Scientometrics*, **75**(2), 289–311.
Bird, B.J., D.J. Hayward and D.N. Allen (1993), 'Conflicts in the commercialization of knowledge: Perspectives from science and entrepreneurship', *Entrepreneurship Theory and Practice*, **17**(4), 57–76.
Blumenthal, D. (1992), 'Academic–industry relationships in the life sciences', *Journal of the American Medical Association*, **268**(23), 3344–9.
Bozeman, B. (2000), 'Technology transfer and public policy: A review of research and theory', *Research Policy*, **29**(4–5), 627–55.
Bozeman, B. (2007), *Public Values and Public Interest: Counterbalancing Economic Iindividualism*, Washington, DC: Georgetown University Press.
Bramwell, A. and D.A. Wolfe (2008), 'Universities and regional economic development: The entrepreneurial University of Waterloo', *Research Policy*, **37**(8), 1175–87.
Bray, M.J. and J.N. Lee (2000), 'University revenues from technology transfer: Licensing fees vs. equity positions', *Journal of Business Venturing*, **15**(5–6), 385–92.
Burczak, T. (2002), 'A critique of Kirzner's finders–keepers defense of profit', *Review of Austrian Economics*, **15**(1), 75–90.
Chang, Y.C. and P.Y. Yang (2008), 'The impacts of academic patenting and licensing on knowledge production and diffusion: A test of the anti-commons effect in Taiwan', *R&D Management*, **38**(3), 321–34.
Chang, Y.C., P.Y. Yang and M.H. Chen (2009), 'The determinants of academic research commercial performance: Towards an organizational ambidexterity perspective', *Research Policy*, **38**(6), 936–46.
Chapple, W., A. Lockett, D.S. Siegel and M. Wright (2005), 'Assessing the relative performance of U.K. university technology transfer offices: Parametric and non-parametric evidence', *Research Policy*, **34**(3), 369–84.
Colyvas, J.A. (2007), 'From divergent meanings to common practices: The early institutionalization of technology transfer in the life sciences at Stanford University', *Research Policy*, **36**(4), 456–76.
Colyvas, J.A. and W.W. Powell (2007), 'From vulnerable to venerated: The institutionalization of academic entrepreneurship in the life sciences', in M. Reuf and M. Lounsbury (eds), *Research in the Sociology of Organizations*, Oxford: JAI Press, pp. 223–66.
Colyvas, J., M. Crow, A. Gelijns, R. Mazzoleni, R.R. Nelson, N. Rosenberg and B.N. Sampat (2002), 'How do university inventions get into practice?' *Management Science*, **48**(1), 61–72.
Cook-Deegan, R. (2007), 'The science commons in health research: Structure, function, and value', *Journal of Technology Transfer*, **32**(3), 133–56.
Crespi, G., P. D'Este, R. Fontana and A. Geuna (2011), 'The impact of academic patenting on university research and its transfer', *Research Policy*, **40**(1), 55–68.
David, P.A. (2004), 'Understanding the emergence of "open science" institutions: Functionalist economics in historical context', *Industrial and Corporate Change*, **13**(4), 571–89.
Debackere, K. and R. Veugelers (2005), 'The role of academic technology transfer organizations in improving industry science links', *Research Policy*, **34**(3), 321–42.
DeConinck, J.B. and W.F. Lewis (1997), 'The influence of deontological and teleological considerations and ethical climate on sales managers' intentions to reward or punish sales force behavior', *Journal of Business Ethics*, **16**(5), 497–506.
Dew, N. and S. Sarasvathy (2007), 'Innovations, stakeholders and entrepreneurship', *Journal of Business Ethics*, **74**(3), 267–83.
Di Gregorio, D. and S. Shane (2003), 'Why do some universities generate more start-ups than others?' *Research Policy*, **32**(2), 209–27.
Douhan, R., G. Eliasson and M. Henrekson (2007), 'Israel M. Kirzner: An outstanding Austrian contributor to the economics of entrepreneurship', *Small Business Economics*, **29**(1), 213–23.
Fabrizio, K.R. and A. Di Minin (2008), 'Commercializing the laboratory: Faculty patenting and the open science environment', *Research Policy*, **37**(5), 914–31.

Feller, I. (1990), 'Universities as engines of R&D-based economic growth: They think they can', *Research Policy*, **19**(4), 335–48.
Feller, I. (1990), 'University patent and technology-licensing strategies', *Educational Policy*, **4**(4), 327–40.
Foss, K., N.J. Foss and P.G. Klein (2007), 'Original and derived judgment: An entrepreneurial theory of economic organization', *Organization Studies*, **28**(12), 1893–912.
Frankema, W.K. (1973), *Ethics*, Eaglewood Cliffs, NJ: Prentice Hall.
Geiger, R.L. (2004), *Knowledge and Money: Research Universities and the Paradox of the Marketplace*, Stanford, CA: Stanford University Press.
Geuna, A. and L.J.J. Nesta (2006), 'University patenting and its effects on academic research: The emerging European evidence', *Research Policy*, **35**(6), 790–807.
Gilsing, V.A., E. van Burg and A.G.L. Romme (2010), 'Policy principles for the creation and success of corporate and academic spin-offs', *Technovation*, **30**(1), 12–23.
Glenna, L.L., R. Welsh, W.B. Lacy and D. Biscotti (2007), 'University administrators, agricultural biotechnology, and academic capitalism: Defining the public good to promote university–industry relationships', *Sociological Quarterly*, **48**(1), 141–63.
Godin, B. and Y. Gingras (2000), 'Impact of collaborative research on academic science', *Science and Public Policy*, **27**(1), 65–73.
Goldstein, H. (2010), 'The "entrepreneurial turn" and regional economic development mission of universities', *Annals of Regional Science*, **44**(1), 83–109.
Gulbrandsen, M. and J.C. Smeby (2005), 'Industry funding and university professors' research performance', *Research Policy*, **34**(6), 932–50.
Haeussler, C. (2011), 'Information-sharing in academia and the industry: A comparative study', *Research Policy*, **40**(1), 105–22.
Haeussler, C. and J.A. Colyvas (2011), 'Breaking the ivory tower: Academic entrepreneurship in the life sciences in UK and Germany', *Research Policy*, **40**(1), 41–54.
Hsu, R.C. and T. Bernstein (1997), 'Managing the university technology licensing process: Findings from case studies', *Journal of the Association of University Technology Managers*, **9**, 1–33.
Jensen, R. and M. Thursby (2001), 'Proofs and prototypes for sale: The licensing of university inventions', *American Economic Review*, **91**(1), 240–59.
Kant, I. (2005), *Groundwork for the Metaphysics of Morals*, Peterborough, ON, originally published 1785: NSW Broadview Press.
Kirzner, I.M. (1989), *Discovery, Capitalism, and Distributive Justice*, Oxford: Basil Blackwell.
Klein, R., U. de Haan and A. Goldberg (2010), 'Overcoming obstacles encountered on the way to commercialize university IP', *Journal of Technology Transfer*, **35**(6), 671–9.
Kleinman, D.L. and S.P. Vallas (2001), 'Science, capitalism, and the rise of the "knowledge worker": The changing structure of knowledge production in the United States', *Theory and Society*, **30**(4), 451–92.
Krimsky, S. (2003), *Science in the Private Interest: Has the Lure of Profits Corrupted Biomedical Research?* Lanham, MD: Rowman and Littlefield Publishers.
Lacetera, N. (2009), 'Different missions and commitment power in R&D organizations: Theory and evidence on industry–university alliances', *Organization Science*, **20**(3), 565–82.
Larsen, M.T. (2011), 'The implications of academic enterprise for public science: An overview of the empirical evidence', *Research Policy*, **40**(1), 6–19.
Lefkowitz, J. (2003), *Ethics and Values in Industrial-Organizational Psychology*, Mahwah, NJ: Lawrence Erlbaum.
Leute, K. (2005), 'Stanford's licensing and equity practices with biotechnology companies', *Journal of Commercial Biotechnology*, **11**(4), 318–24.
Lexchin, J., L.A. Bero, B. Djulbegovic and O. Clark (2003), 'Pharmaceutical industry sponsorship and research outcome and quality: Systematic review', *British Medical Journal*, **326**(7400), 1167–70.
Lowe, R. and C. Gonzalez (2007), 'Faculty entrepreneurs and research productivity', *Journal of Technology Transfer*, **32**(3), 173–94.

Lundström, A. and L.A. Stevenson (2005), *Entrepreneurship Policy: Theory and Practice*, Boston: Springer.
Mars, M.M., S. Slaughter and G. Rhoades (2008), 'The state-subsidized student entrepreneur, *Journal of Higher Education*, **79**(6), 638–70.
Martinelli, A., M. Meyer and N. von Tunzelmann (2008), 'Becoming an entrepreneurial university? A case study of knowledge exchange relationships and faculty attitudes in a medium-sized, research-oriented university', *Journal of Technology Transfer*, **33**(3), 259–83.
Merton, R.K. (1973), *The Sociology of Science: Theoretical and Empirical Investigations*, Chicago: University of Chicago Press.
Meyer, M. (2006), 'Academic inventiveness and entrepreneurship: On the importance of start-up companies in commercializing academic patents', *Journal of Technology Transfer*, **31**(4), 501–10.
Micewski, E. and C. Troy (2007), 'Business ethics – deontologically revisited', *Journal of Business Ethics*, **72**(1), 17–25.
Mitchell, R.K., L. Busenitz, T. Lant, P.P. McDougall, E.A. Morse and J.B. Smith (2002), 'Toward a theory of entrepreneurial cognition: Rethinking the people side of entrepreneurship research', *Entrepreneurship Theory and Practice*, **27**(2), 93–104.
Mitroff, I.I. (1974), 'Norms and counter-norms in a select group of the Apollo moon scientists: A case study of the ambivalence of scientists', *American Sociological Review*, **39**(4), 579–95.
Montgomery, K. and A.L. Oliver (2009), 'Shifts in guidelines for ethical scientific conduct: How public and private organizations create and change norms of research integrity', *Social Studies of Science*, **39**(1), 137–55.
Mowery, D.C. and B.N. Sampat (2005), 'Universities in national innovation systems', in J. Fagerberg, D.C. Mowery and R.R. Nelson (eds), *Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp. 209–39.
Mueller, P. (2006), 'Exploring the knowledge filter: How entrepreneurship and university–industry relationships drive economic growth', *Research Policy*, **35**(10), 1499–508.
Murray, F. and S. Stern (2007), 'Do formal intellectual property rights hinder the free flow of scientific knowledge? An empirical test of the anti-commons hypothesis', *Journal of Economic Behavior and Organization*, **63**(4), 648–87.
O'Shea, R.P., T.J. Allen, A. Chevalier and F. Roche (2005), 'Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities', *Research Policy*, **34**(7), 994–1009.
Owen-Smith, J. and W.W. Powell (2001), 'Careers and contradictions: Faculty responses to the transformation of knowledge and its uses in the life sciences', *Research in the Sociology of Work*, **10**, 109–40.
Owen-Smith, J. and W.W. Powell (2003), 'The expanding role of university patenting in the life sciences: Assessing the importance of experience and connectivity', *Research Policy*, **32**(9), 1695–711.
Perkmann, M. and K. Walsh (2007), 'University–industry relationships and open innovation: Towards a research agenda', *International Journal of Management Reviews*, **9**(4), 259–80.
Perkmann, M. and K. Walsh (2008), 'Engaging the scholar: Three types of academic consulting and their impact on universities and industry', *Research Policy*, **37**(10), 1884–91.
Powell, W.W. and J.A. Colyvas (2008), 'The microfoundations of institutions', in R. Greenwood, C. Oliver, K. Sahlin and R. Suddaby (eds), *Handbook of Organizational Institutionalism*, London: Sage Publications, pp. 267–89.
Powell, W.W. and J. Owen-Smith (2002), 'The new world of knowledge production in the life sciences', in S. Brint (ed.), *The Future of the City of Intellect: The Changing American University*, Stanford, CA: Stanford University Press, pp. 106–32.
Powers, J.B. and P. McDougall (2005), 'Policy orientation effects on performance with licensing to start-ups and small companies', *Research Policy*, **34**(7), 1028–42.
Powers, J.B. and P.P. McDougall (2005), 'University start-up formation and technology

licensing with firms that go public: A resource-based view of academic entrepreneurship', *Journal of Business Venturing*, **20**(3), 291–311.
Rappert, B., A. Webster and D. Charles (1999), 'Making sense of diversity and reluctance: Academic–industrial relations and intellectual property', *Research Policy*, **28**(8), 873–90.
Rawls, J. (1999), *A Theory of Justice*, revised edition, Cambridge, MA: Harvard University Press.
Renault, C. (2006), 'Academic capitalism and university incentives for faculty entrepreneurship', *Journal of Technology Transfer*, **31**(2), 227–39.
Rhoten, D. and W.W. Powell (2007), 'The frontiers of intellectual property: Expanded protection versus new models of open science', *Annual Review of Law and Social Science*, **3**, 345–73.
Sarasvathy, S.D., N. Dew, S.R. Velamuri and S. Venkataraman (2003), 'Three views of entrepreneurial opportunity', in Z.J. Acs and D.B. Audretsch (eds), *Handbook of Entrepreneurship Research: An Interdisciplinary Survey and Introduction*, Dordrecht: Kluwer Academic Publishers, pp. 141–60.
Shane, S. (2000), 'Prior knowledge and the discovery of entrepreneurial opportunities', *Organization Science*, **11**(4), 448–69.
Shane, S. (2002), 'Selling university technology: Patterns from MIT', *Management Science*, **48**(1), 122–37.
Shane, S. (2004), *Academic Entrepreneurship: University Spinoffs and Wealth Creation*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
Shane, S. (2009), 'Why encouraging more people to become entrepreneurs is bad public policy', *Small Business Economics*, **33**(2), 141–9.
Siegel, D.S., R. Veugelers and M. Wright (2007), 'Technology transfer offices and commercialization of university intellectual property: Performance and policy implications', *Oxford Review of Economic Policy*, **23**(4), 640–60.
Siegel, D.S., D.A. Waldman, L.E. Atwater and A.N. Link (2004), 'Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: Qualitative evidence from the commercialization of university technologies', *Journal of Engineering and Technology Management*, **21**(1–2), 115–42.
Slaughter, S. and L.L. Leslie (1997), *Academic Capitalism: Politics, Policies, and the Entrepreneurial University*, London: Johns Hopkins University Press.
Slaughter, S. and G. Rhoades (2004), *Academic Capitalism and the New Economy*, Baltimore, MD and London: Johns Hopkins University Press.
Smith, R. (1998), 'Beyond conflict of interest', *British Medical Journal*, **317**(7154), 291–92.
Steffensen, M., E.M. Rogers and K. Speakman (2000), 'Spin-offs from research centers at a research university', *Journal of Business Venturing*, **15**(1), 93–111.
Stevens, J.M. and J.W. Bagby (2001), 'Knowledge transfer from universities to business: Returns for all stakeholders?' *Organization*, **8**(2), 259–68.
Tartari, V. and S. Breschi (2012), 'Set them free: Scientists' evaluations of the benefits and costs of university–industry research collaboration', *Industrial and Corporate Change*, **21**(5), 1117–47.
Thursby, J.G. and M.C. Thursby (2005), 'Pros and cons of faculty participation in licensing', in G.D. Libecap (ed.), *University Entrepreneurship and Technology Transfer: Process, Design, and Intellectual Property*, Oxford: Elsevier, pp. 187–210.
Thursby, J.G., R. Jensen and M.C. Thursby (2001), 'Objectives, characteristics and outcomes of university licensing: A survey of major U.S. universities', *Journal of Technology Transfer*, **26**(1–2), 59–72.
Thursby, M., J. Thursby and S. Gupta-Mukherjee (2007), 'Are there real effects of licensing on academic research? A life cycle view', *Journal of Economic Behavior and Organization*, **63**(4), 577–98.
Vallas, S. and P. Kleinman (2007), 'Contradiction, convergence and the knowledge economy: The confluence of academic and commercial biotechnology', *Socio-Economic Review*, **30**(4), 1–25.
van Burg, E., A.G.L. Romme, V.A. Gilsing and I.M.M.J. Reymen (2008), 'Creating university spin-offs: A science-based design perspective', *Journal of Product Innovation Management*, **25**(2), 114–28.
van Looy, B., J. Callaert and K. Debackere (2006), 'Publication and patent behavior of academic researchers: Conflicting, reinforcing or merely co-existing?' *Research Policy*, **35**(4), 596–608.
Welsh, R., L. Glenna, W. Lacy and D. Biscotti (2008), 'Close enough but not too far: Assessing the effects of university–industry research relationships and the rise of academic capitalism', *Research Policy*, **37**(10), 1854–64.
West, J. (2008), 'Commercializing open science: Deep space communications as the lead market for Shannon theory, 1960–73', *Journal of Management Studies*, **45**(8), 1506–32.
Ylijoki, O.H. (2003), 'Entangled in academic capitalism? A case-study on changing ideals and practices of university research', *Higher Education*, **45**(3), 307–35.
Zucker, L.G. and M.R. Darby (1998), 'Entrepreneurs, star scientists, and biotechnology', *NBER Reporter*, Fall, 7–11.
Zucker, L.G., M.R. Darby and J.S. Armstrong (2002), 'Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology', *Management Science*, **48**(1), 138–53.